Bear Creek Fish Investigations, 2003: Population and Habitat Surveys

by

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Introduction

The Gallatin National Forest (GNF), in cooperation with Gallatin Local Water Quality District and Bear Creek Canyon homeowners, performed a fisheries and habitat survey of Bear Creek October and December, 2003. The objective of this survey was to assess fish populations and habitat with respect to natural variables, trail and road motorized use, and downstream residential and agricultural activities.

The purpose of collecting this data was to meet the objectives of a larger water quality monitoring project in Bear Creek. Data collected by the water monitoring project will be used for a Beneficial Use Determination by Montana DEQ, the completion of the Gallatin NF Travel Management Plan, and to respond to local public concern, primarily Bear Canyon homeowners.

Study Site

Bear Canyon Creek is a second order stream located in southwest Montana, near Bozeman. Bear Creek and its tributaries drain about 46 km^2 of watershed. Its confluence with Rocky Creek forms the East Gallatin River (T2S R6E S23).

On October 14, 15, and December 2, 2003, fish populations and habitat conditions were evaluated at four sites on Bear Creek. The first three of these sites correspond to locations where the most intensive water quality data were recorded (water monitoring sites 1, 3, 5), whereas the latter site, at LaMotte School, falls between water quality monitoring sites 7 and 8 (see Story 2003 for more detailed description of these sites). Data at this site were collected collaboratively with LaMotte school students. Together, these four sites encompass the range of impacts present in Bear Canyon Creek: livestock grazing and trail impacts (sites 1 and 3); combined trail and road impacts (site 5); and intensive livestock grazing (LaMotte School). These sites also encompass the range of channel types present: sites 1, 3, and LaMotte School are low gradient, C channels, whereas site 5 is a B channel (Rosgen 1994). Sites 1, 3, and 5 are in forested reaches, whereas LaMotte is in an agricultural reach.

Bear Canyon 2003 Fish and Habitat Sampling Sites

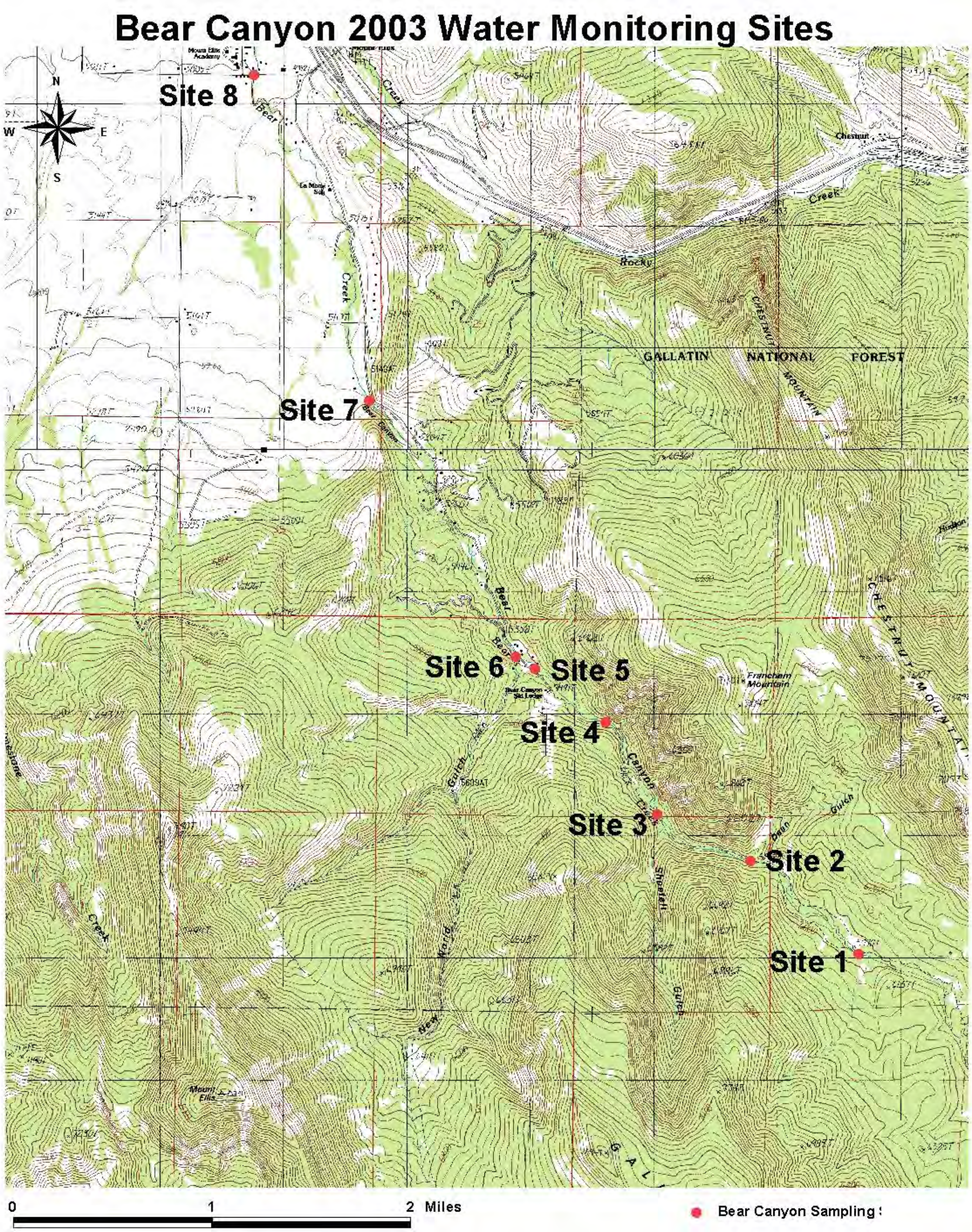

Figure 1. Fish and habitat data sample sites 1,3,5, and LaMotte School (From Story 2003).

Methods

Fish Inventory

Fish were collected using a Smith-Root model 12-A backpack shocker. Settings were adjusted to water temperatures and conductivity (2-4^{o}C, ~230 uS/cm). Sampled sections were at least 100 m upstream of water quality monitoring site makers, but the terminal points of each section were adjusted to incorporate complete habitat units (pool or riffle).

Captured trout were enumerated, measured (mm) and length frequency distributions compiled for identification of age classes. Other captured species were enumerated and released. Captured trout were examined for external anomalies, parasites, and evidence of hybridization. Population estimates, 95% confidence intervals, and fish densities were calculated for trout using a two-pass fish population estimate (Steve Leathe, Montana Fish, Wildlife and Parks internal memo, 1983). Separate estimates were made by species except at LaMotte, where data categories were simplified to allow students to quickly collect data. Rainbow trout (*Oncorhynchus mykiss*), cutthroat trout (*O. clarki*) and putative hybrids (*O. mykiss X O. clarki*) were combined for estimates because of the difficulty in definitively classifying them.

Physical and Chemical Habitat Characteristics

Habitat surveys were performed along fish sampling reaches, using a modified R1R4 Fish Habitat Stream Inventory (Overton et al.1997). We measured all habitat units using a calibrated hipchain and stadia rod (m). Visual observations of surface fines (< 2 mm) in potential trout spawning areas were recorded using the method described by Mullner et al. (2000) that relates surfaces fines to those within the substrate matrix. Substrate size classes were visually observed and recorded to the nearest five percent. Large woody debris (LWD) (three meters in length, or > 2/3 the wetted width of the stream and 0.1 meter in diameter) were counted (Overton et al.1997). Channel types were classified using the Rosgen classification system (Rosgen 1994). Lengths of unstable and undercut banks were measured (m) using the hip chain. Under- and over-story vegetative species were recorded and land usage was qualitatively noted.

Results

Fish Inventory

Five salmonid species were represented in our samples: rainbow trout, cutthroat trout, rainbow-cutthroat hybrids, brown trout (*Salmo trutta*) and brook trout (*Salvelinus fontinalis*). Morphologically, putative cutthroats appeared to represent both Yellowstone (*O. clarki bouvieri*) and westlope (*O. clarki lewisi*) cutthroat subspecies. Brown trout were captured at only the LaMotte site, cutthroats and hybrids at sites 1 and 3, and the remaining species at all four sites. Mottled sculpin (*Cottus bairdi*) were present, and relatively abundant, at all sites. Short gill covers (opercula not fully covering the gills) were noted on 11% of all brook trout at sites 1, 3, and 5 (9%, 12%, and 8%, respectively); no other anomalies or parasites were noted.

Brook trout predominated catch at all sites, but this dominance decreased from upstream to downstream; brook trout represented 94% of trout at site 1 (Table 1) but about 50% at LaMotte School. Similarly, cutthroat trout and rainbow-cutthroat hybrids were more common in upstream sites (1 and 3), and rainbow trout at downstream sites (5 and LaMotte). Trout abundance and densities were highest at site 3, moderate at site 1 and LaMotte, and lowest at site 5 (Table 1). Multiple year classes were noted at all sites (See Appendix A for length-frequencies). The youngest age-classes of rainbow were missing at sites 1 and 3, whereas older brook trout year classes (ages 3 and 4) were weak at sites 1 and 5. The youngest year classes of brook trout were strong at sites 1, 3, and 5.

Table 1. Fish population estimates (95% confidence intervals), fish densities, and fish length ranges at Bear Creek fish sampling sites, 2003.

Site	**1**	**3**	**5**	**LaMotte**
Pop. Est. (95% CI)				
Rainbow Trout	5 (5-9)	18 (14-22)	12 (6-18)	NA
Brook Trout	79 (67-91)	139 (127-151)	28 (24-32)	NA
All Trout	85 (81-91)	156 (147-166)	40 (37-46)	107 (96-120)
Length Range (mm)				
Rainbow Trout	124-165	96-294	54-228	
Brook Trout	70-230	60-259	60-224	
All Trout	70-230	60-294	54-228	80-335
Fish Density (fish/m^2)	0.26	0.53	0.13	0.28

Physical Habitat Characteristics

Residual pool depths were greatest at sites 3 and LaMotte, whereas total pool area was greatest at site 1 and least at site LaMotte (Table 2). Overall, pool habitat quality and abundance was lowest at sites 5 and LaMotte.

At all sites, local geology appeared to predispose streambanks to natural instability that was easily exacerbated by even low levels of disturbance (Table 2). Site 1 had largest amounts of both unstable and undercut bank, but the unstable banks were common at the other three sites as well. At sites 1 and 3, streambanks were destabilized by localized, moderate to low cattle impacts. Additionally, a trail crossing through site 1 caused localized instability. At site 5, unstable banks were increased by channel adjustments resulting from channel modification at an old lumbermill upstream. At the LaMotte site, intensive cattle use of the riparian area locally destabilized banks, both by hoof shear and vegetation removal. As a result of these sediment sources, the amounts of surface fines (<2 mm) in potential trout spawning areas were greater than 25% (Table 2). Furthermore, these amounts were inversely related to stream energy (lowest at site 5 and highest at site 1). Large woody debris was common at forested sites (1, 3, 5) and uncommon at the unforested site (LaMotte) (Table 2).

Table 2. Fish habitat characteristics of surveyed reaches, Bear Creek, 2003.

Site	**1**	**3**	**5**	**LaMotte**
Total Reach length (m)	135	118	145	151
Pools/km Mean Residual Pool Depth (m) Total Pool Area (m^2) Pool (% of reach)	44 0.32 157 45	51 0.45 98 33	34 0.30 51 17	33 0.58 40 11
Unstable bank (% of Reach)	17	8	11	25
Undercut bank (% of Reach)	15	8	3	1
LWD/km	200	195	303	0
Substrate Surface Fines < 2 mm (% of total)	45	35	25	30

Discussion and Conclusions

Of the habitat parameters measured in this study, fine sediment (< 2 mm) levels consistently exceeded levels considered potentially limiting to trout populations. In general, increased fine sediment levels (>25%) may reduce spawning success (Chapman 1988, Young et al. 1989a), overwintering survival, quality of pool habitats, and macroinvertebrate food sources (Hicks et al. 1991). Qualitative observations indicate that fine soils present in the Bear Creek watershed are available for transport into the stream even at relatively undisturbed sites, due to sparse vegetative cover. These soils are easily disturbed; at site one, a single pass of a cow along one bank noticeably resulted in hoof shear, destabilized bank, and localized sediment supply to the stream.

Although fine sediment levels are high enough to potentially limit trout populations, through reduced spawning success or other mechanisms in Bear Creek, we did not detect an apparent population density effect in our sampling. With the exception of site 5, trout densities in Bear Creek are comparable to or higher than other streams on the GNF (Table 3). Other studies indicate that available rearing habitat, not reduced spawning success, may limit salmonid populations except when spawning success is very low, or that a few sites with high quality spawning habitat in a watershed may offset generally poor spawning habitat quality (Everest et al. 1987, Magee 1996). However, chronic

Table 3. Comparison of trout densities among streams on the Gallatin National Forest. Data are from project files at Bozeman Ranger District, except those from Upper Wapiti Creek which are from Ireland (1993).

Stream	Trout Density (#/m^2)	Species Present	Disturbance Level
Cache Creek	0.26	WCt X Rb	High
Deadhorse Creek	0.23	WCt X Rb	Low
Upper Wapiti Creek	0.18-0.28	WCt X Rb	Low
Bangtail Creek	0.30	YCt, Eb	High
MF Brackett Creek	0.20	YCt, Eb	Moderate
Bear Creek	0.13-0.53	Rb, Rb X Ct, Eb	Moderate to High

reduced spawning success may render trout populations more susceptible to other habitat perturbations (e.g. drought, flood, wildfire), disease (e.g. whirling disease), competition with other species or other factors (Rieman and McIntyre 1993). This is especially true if trout populations are supported by only a few high quality spawning habitats within a watershed.

Weak year classes of older brook trout were evident at two sites (1 and 5) (see appendix A for figures). It is difficult to ascertain causation from one year's sampling, but such missing year classes may note reduced survival under different conditions than those producing the apparently robust younger year classes we observed. For example, Story (2003) noted that very little elevated discharge occurred in Bear Creek in 2003.

The distribution of fish in Bear Creek is not surprising. In mountain stream habitats, brook trout often predominate in upstream reaches, rainbow trout in intermediate, and brown trout farthest downstream (summarized in Weigel and Sorenson 2001). These distribution patterns are attributed to changes in elevation and gradient, along with their effects on stream morphology and other characteristics. The dominance of brook trout at higher elevations, and the lack of younger year classes of rainbow trout at sites 1 and 3 in this study, may be related to the ability of brook trout to use groundwater sources for spawning. The stability of groundwater temperatures allows embryo survival during very cold winter temperatures, but also to use otherwise unsuitable spawning habitats – including those with high levels of fine sediments (Curry et al. 1995, Waters 1995).

Pool habitat as a proportion of total habitat was limited at sites 5 and LaMotte, and borderline at site 3, when compared to habitat suitability values for trout (35-60%; Hickman and Raleigh 1982, Raleigh et al. 1984). However, the quality of pools at sites 3 and LaMotte was high, as indicated by residual pool depths and resulted in the highest fish densities we observed in this study. Fish densities at site 5, which had the lowest quality pool habitat, were the lowest we observed and indicate a habitat limitation.

Whereas other habitat parameters besides fine sediment were generally indicative of moderate to high quality habitat in the sections we sampled (with exceptions noted above), other stream reaches we qualitatively observed were obviously highly disturbed. This disturbance occurred as result of roads and trails built along, and through, the stream course between sites 3 and 5 (T3S R7E S6) (see Story 2003 for detailed description). In these cases, the stream was overwidened and shallow, streambanks were destabilized and providing fine sediment to the stream, and fish habitat quality was low.

In summary, the sensitive nature of the soils in the Bear Creek watershed, the high fine sediment levels observed throughout Bear Creek, obvious habitat alteration and the indications of reduced rearing habitats and missing year classes of trout at some sites show the need to carefully consider the kinds and locations of activities in the watershed. In particular, livestock grazing and use/location/maintenance of roads and trails should be evaluated and managed to reduce potential effects of chronic high fine sediment loading and other fish habitat degradation on Bear Creek. Although the present study did not definitively document trout population effects, the scope of the study is insufficient to determine long-term effects of habitat modification and chronic fine sedimentation.

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APPENDIX A

FIGURES RELATING TO RESULTS

Figure 1.

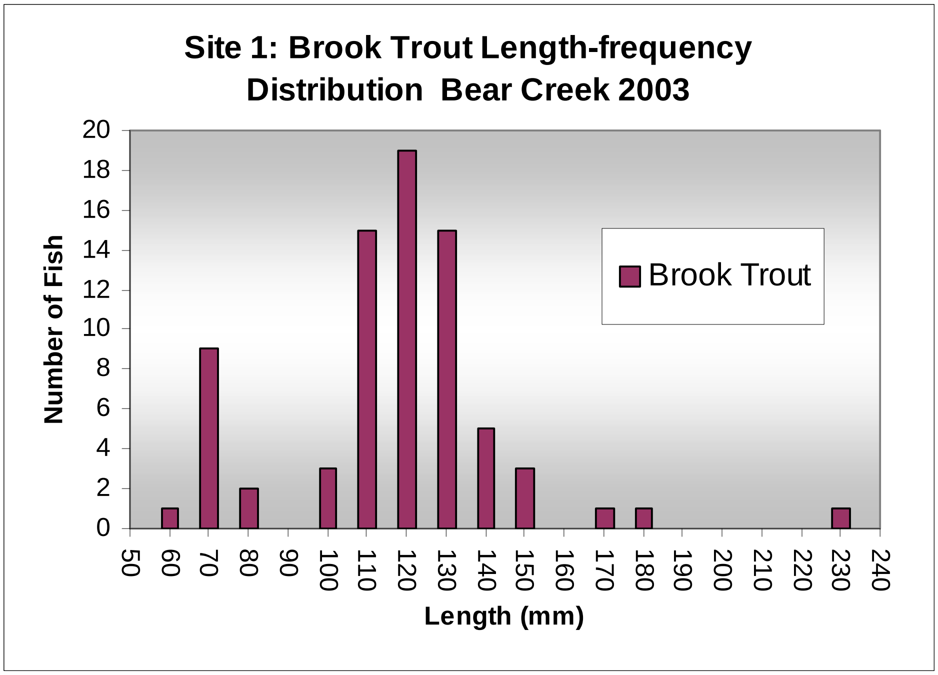

Figure 2.

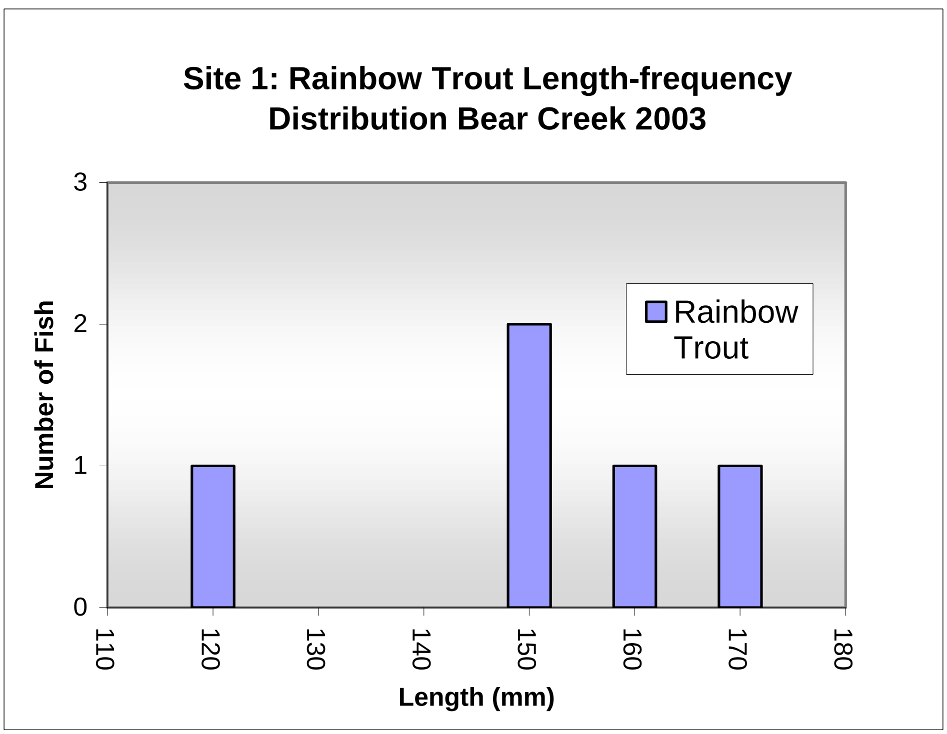

Figure 3

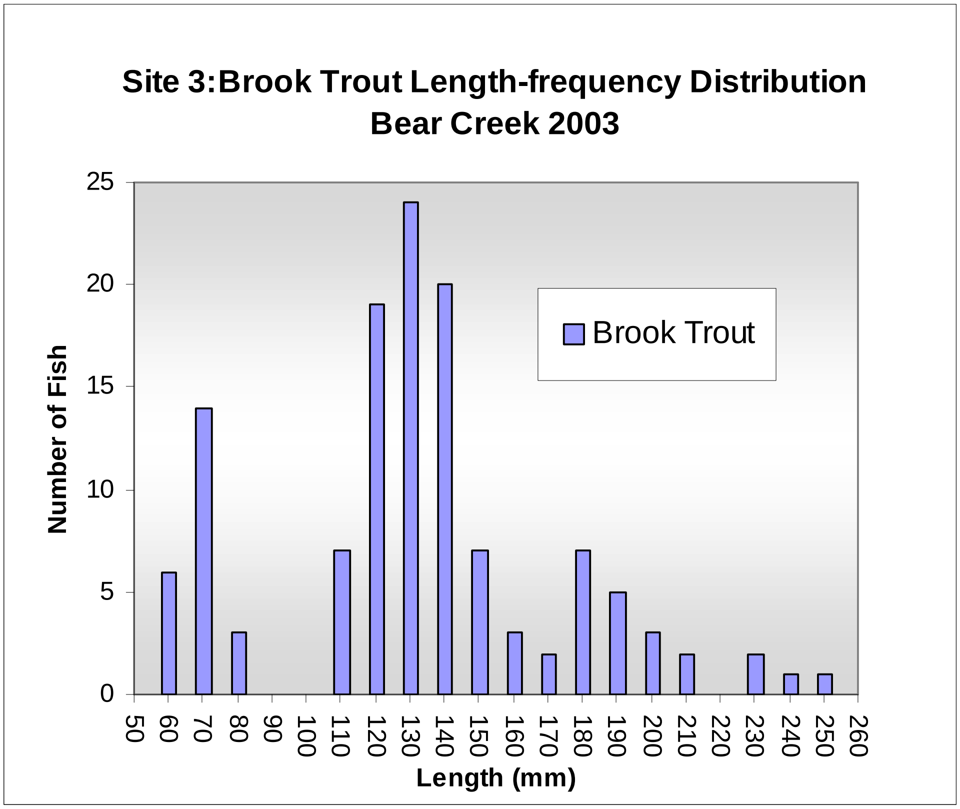

Figure 4.

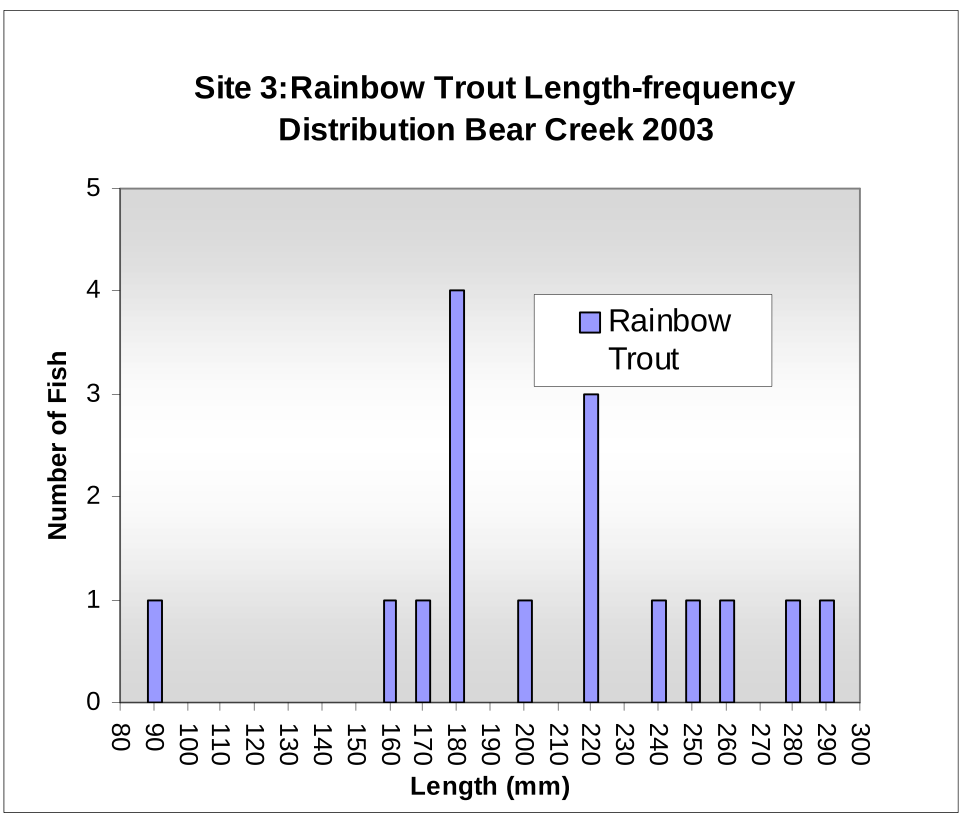

Figure 5.

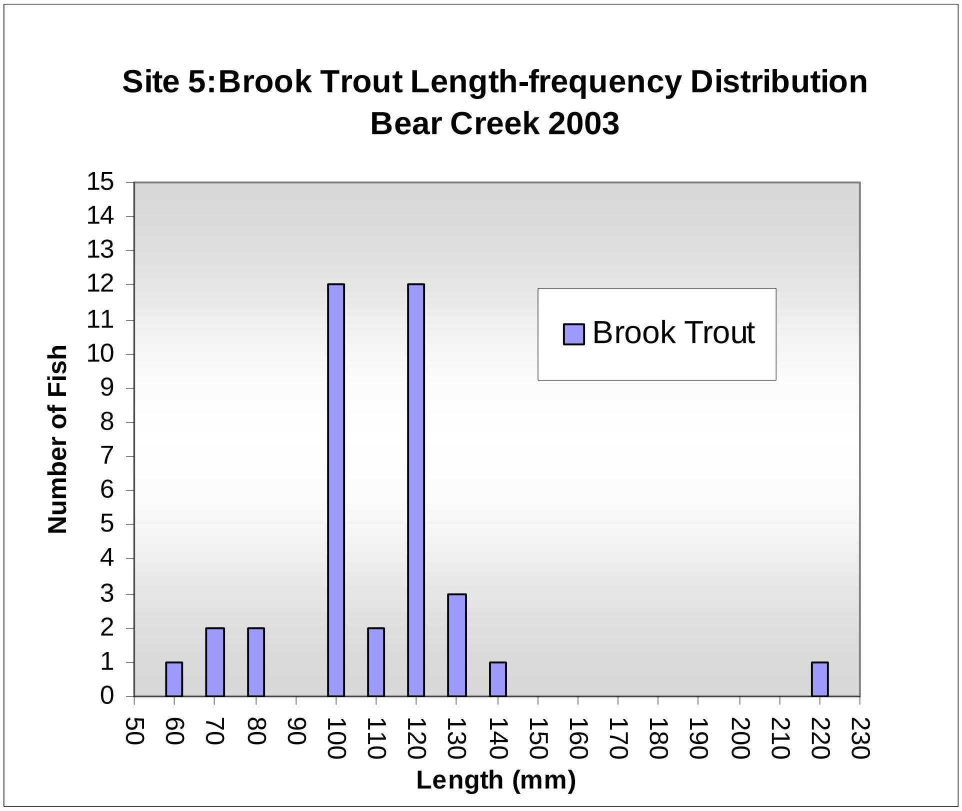

Figure 6.